Improving On-Farm Food Safety Through Good Irrigation Practices

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Factsheet

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IRRIGATION WATER QUALITY CONCERNS

Water is important in crop production because it is used in many activities such as irrigating, washing and cooling. Irrigation water can spread pathogens, microorganisms that cause disease in humans, such as *Salmonella* spp., *E. coli* O157:H7 and *Cryptosporidium parvum* (also known as "Crypto"). Every time contaminated water comes in direct contact with fruit or vegetables, there is a risk that these pathogens may be transferred to the produce.

Testing irrigation water for pathogens and keeping water test records are good agriculture practices and an important part of an on-farm food safety planning. This Factsheet discusses the potential risks associated with irrigation water, guidelines for testing irrigation water, interpretation of test results and best management practices for preventing contamination of fruit and vegetable crops with irrigation water.

RISKS OF FOOD-BORNE ILLNESS CAUSED BY IRRIGATION WATER

The microbial risk depends on:

- the numbers and types of pathogens present and the susceptibility of the person consuming the product
- the characteristics of the crop
- the water source
- the method of irrigation
- the time of application in relation to harvest

Type of Pathogen

For some pathogens, e.g. *E. coli* O157:H7, the ingestion of only a few (less than 10) cells may be enough to cause illness. The risk of someone ingesting one or more pathogens depends on that pathogens ability to survive on the produce.

The very young (under five years of age), the elderly and those who are immune compromised are most susceptible to food-borne illness from low levels of pathogens. According to the latest figures from Statistics Canada, the fastest growing segment of the Canadian population is aged 80 and over.

Crop Characteristics

Fruit and vegetables with large surface areas that can trap and hold moisture, such as lettuce, are at greater risk of containing living pathogens. Fruit or vegetables that are eaten raw or unpeeled present a higher risk. Processing or cooking produce reduces the potential for pathogens to survive.

Water Source

Irrigation water comes from two main sources: surface water or ground water. Surface water includes lakes, rivers, creeks, ponds and springs that come to the surface. Wells are ground water sources. In Ontario, surface water is the most common source for irrigation. Generally, water from surface sources has a higher chance of contamination than water from ground water sources.

Water can be contaminated by:

- livestock or wildlife feces
- run-off from manure storages
- faulty septic systems
- storm runoff

Surface water sources have the most **variable** levels of contamination because they may be subject to temporary or intermittent contamination sources. Rivers, streams and creeks have unpredictable water quality since activities upstream can rapidly change the levels of contamination entering the flowing water. Lakes tend to have better water quality; however, this may be compromised near an inflow from a river or creek or by activities causing contamination around or on the lake. The water quality in a pond depends on the source of the water for the pond and how well the pond is protected from further contamination. Ponds filled by a river, ditch or runoff will tend to have lower water quality than a pond filled by ground water, a spring or well.

When heavy rainfall occurs, the added volume can stir up the sediment at the bottom of a pond, creek or river. This sediment-laden water can contain higher levels of bacteria than calm water because bacteria tend to stick to sediment particles.

Ministry of Agriculture, Food and Rural Affairs

Ontario

Irrigation water taken directly from a well or a municipal source generally provides water of the most reliable quality. Ground water has gone through a natural filtration process as it travels through soil layers into the aquifer. There is still a potential for contamination to occur and well users must be vigilant in properly siting, constructing, maintaining and decommissioning their wells.

Water Source Type	Water Quality Variability
River or stream	High variability
Pond filled by stream, ditch or runoff	High variability
Lake	Medium variability
Pond filled by ground water, spring or well	Medium variability
Well supplying directly to irrigation system	Low variability
Municipal water source	Low variability

Irrigation method

Methods of irrigation in Ontario include overhead (sprinkler) irrigation or trickle (drip) irrigation. Irrigation water that does not contact the edible part of the plant, such as trickle irrigation, is considered a lower risk for contaminating produce. Mini-sprinklers that apply water below the crop canopy present less risk than overhead sprinklers or pivots.

Timing of irrigation

Although there has been little research in this area, the risk of ingesting pathogens is higher when the product comes in contact with contaminated water near harvest time or during post harvest handling. The pathogen is more likely to still be alive when there is only a short period between contamination and consumption.

HOW TO TEST IRRIGATION WATER

Taking a sample

Water samples collected for microbial analysis can be easily contaminated. Tools and containers for collecting and storing the sample should be clean and free from microorganisms. Most laboratories will provide a sterile container on request.

Collect the water sample at the point where it contacts produce — such as out of an irrigation line. Another option is to sample the source water directly. When sampling surface water, use a weighted pail or sampling cup to get the sample as close to the intake as possible. If sampling out of an irrigation system, allow the system to run for at least 15 minutes before taking a sample at the end of a drip line or sprinkler head. Refrigerate the water sample **immediately** and have it transported under refrigerated conditions to a lab within 24 hours.

Choosing a laboratory for sample analysis

Local health units may provide testing services. A list of Ontario municipal health units may be found on the Ministry of Health website at *www.health.gov.on.ca/english public/contact/contact_mn.html*

Several laboratories in Ontario perform microbial water testing. Choose a laboratory that has third party accreditation with a recognized body (e.g. Standards Council of Canada). For more information on labs accredited for specific tests check the Canadian Association for Environmental Analytical Laboratories website *www.caeal.ca/*.

The Ministry of the Environment has a list of licensed laboratories that perform drinking water testing *www.ene.gov.on.ca/en/water/sdwa/licensedlabs.php*

Notify the lab of the source of the water sample (surface water or well water) because there are different standards for drinking and irrigation water. Keep copies of all test results on file. If using municipal water, get copies of water quality reports from the municipality and keep these in your files.

Frequency of testing

The frequency of water testing depends on the risk factors already described (e.g. crop type) and the variability of the water source (e.g. municipal versus river). Test water from higher risk or variable sources more frequently. Some on-farm food safety programs recommend that closed, underground or capped well systems be tested annually at the beginning of the growing season and surface water be tested at least quarterly during the crop season. However, for higher risk crops such as lettuce, some buyers require their producers to test water monthly.

Keep in mind that water contamination is often intermittent and pathogens do not distribute uniformly in water. Therefore, even a negative test does not guarantee the absence of pathogenic bacteria. Regular testing increases the opportunity to discover contamination.

INTERPRETING THE RESULTS

Washing and Cooling water

Water used for washing and cooling of fresh, ready-to-eat fruit and vegetables must be of potable quality – meaning the water must comply with Ontario Drinking Water Quality Standards.

Ontario Drinking Water Quality Standards (Safe Drinking Water Act, 2002 – O.Reg. 169/03)

- *E. coli*: not detected in 100 mL water and
- total coliforms: not detected in 100 mL water

Source: Ontario Ministry of the Environment. 2003. Ontario Drinking-Water Quality Standards, Objectives and Guidelines. www.ene.gov.on.ca/envision/techdocs/4449e.htm

Irrigation Water

Water used for irrigation should comply with the Canadian Water Quality Guidelines for Irrigation Water.

Canadian Water Quality Guidelines for Irrigation Water

- Fecal coliforms (*Escherichia coli*): ≤100 bacteria per 100 mL water
- Total coliforms: ≤1,000 bacteria per 100 mL water

Source: Environment Canada, 2002. Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses http://ceqg-rcqe.ccme.ca/

GUIDELINES BACKGROUND

Fecal coliforms or generic E. coli are used as indicators of fecal contamination in the water, which indicate that pathogens may be present. If pathogens are in the irrigation water it may potentially contaminate the produce. While testing for specific pathogens is possible, it is less expensive to test for an indicator organism that will indicate the *potential* for pathogens in the water.

What makes an ideal test for indicators of fecal contamination? It should detect the presence of microorganisms that: 1) are present only when contamination from a fecal source has taken place; 2) have the same survival characteristics as the target pathogen for which they are acting as a stand in; 3) do not readily grow in water or soil; 4) are readily monitored in a quick and easy manner. At the present time, no indicators in common use meet all these criteria. Finding "best" indicators and appropriate tests for their presence is an active area of research.

The most commonly used indicators for microbial quality of water are total coliforms, fecal coliforms and generic *E. coli* (Figure 1).

Total coliforms: Approximately 10% of the bacteria found in human and animal intestinal wastes are coliforms. This bacterial group is a good indicator for drinking water supply systems. Unfortunately, some coliforms may grow in decaying organic matter and this group of bacteria is not always a reliable indicator of fecal contamination for surface waters.

Fecal coliforms: This group of bacteria is a subset of coliforms that are able to grow at 44.5°C (112°F). The subset includes *E. coli* but can also include other bacteria that grow at this temperature. Some of these are not necessarily associated with fecal contamination.

Generic *E. coli*: This group of bacteria is found in the intestines of animals and humans. The presence of generic *E. coli* provides the best evidence of fecal contamination at this time.

It is important to remember that not finding an indicator organism does not guarantee absence of pathogenic bacteria nor does it mean that contamination cannot or will not occur.

PROTECTING THE WATER SOURCE

Protect your water source in order to safeguard the quality of your water. Establish a buffer (area free from contaminants) around your pond, well or stream. Limit access by wildlife and domestic animals to your water source (Figure 2). Locate septic systems away from water source and ensure that tank is well maintained. Finally, be aware of all sources of contamination (e.g. manure piles, feedlots, faulty septic systems, chemical storage, etc.) and locate them away from your water source

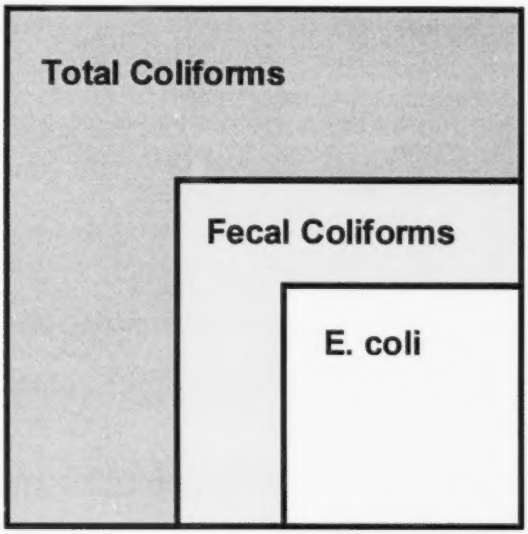

Figure 1. Relationship of total coliforms, fecal coliforms and generic *E. coli*. (Note: not to scale.)

Figure 2. Creek fenced off with 5 strands of barbed wire 3 m from bank edge. Fence installed to reduce access by wildlife and domestic animals.

Table 1. Best Management Practices for Different Water Sources

Water Source	Best Management Practices
Streams	• Use an off stream settling pond – allows large particles that may contain pathogens to settle out of the water and reduce the potential contaminant load. • Work with neighbours to reduce livestock access to water sources. • Establish vegetative buffer zones to filter water and slow down run-off.
Ponds	• Fence pond to prevent animals, both wildlife and domestic, from defecating in or near water. • Re-direct runoff so that it flows around the pond and avoids contaminants entering pond through runoff. (e.g. form a bank around pond or channel ditches away from pond). • Establish grassed waterways or vegetative buffer strips to filter water before it enters the pond. • Install steep sides or rocky berms to discourage geese from nesting.
Stream-fed Ponds	• Avoid harvesting water during the peak flows after a rainfall – this water carries the majority of the sediment (and possibly pathogens) washed by the rainfall. • Establish vegetative buffer zones to filter water and slow down run-off.
Wells	• Mound up the ground around the outside of the well or well pit with clean earth to provide drainage for surface water so that runoff flows away from the well. • Maintain well casing above grade. • Ensure that well casing is intact and there are no cracks or openings • Don't allow any space between the well casing and the surrounding soil (this could act as a pathway for surface water to contaminate the well). • For more information see: o Best Management Practices book 12, Water Wells o Ministry of Environment Green Facts Series: *The Protection of Water Quality in Drilled Wells, The Protection of Water Quality in Bored and Dug Wells, The Protection of Water Quality in Jetted or Dr[illegible]n Well Points* o Min[illegible]ry of Environment web site – see Green Facts Series at *www.ene.gov.on.ca/envision/water/wells.htm* or call Ministry of Environment at 1-800-565-4923

Choose the appropriate water source for your crop. If water does not meet the recommended guidelines consider using a form of irrigation where the water does not come into contact with the produce i.e. trickle irrigation. Finally, treatment of the irrigation water may be necessary if water quality is poor and no alternative water sources are available.

REDUCING RISK OF CONTAMINATION

If your water is on average above the suggested guidelines, you can reduce the risk of contamination. Examples:

- choose a different irrigation method (i.e. drip or trickle rather than overhead sprinklers)
- choose a different water source or
- for some applications, treat the water to improve its quality.

There are many ways to eliminate pathogens from water (water treatment). Some of these options have potential for water used in spray applications (pesticide and herbicide) and post harvest applications (product washing). Most are impractical for the large volumes and high flow rates associated with overhead and sprinkler irrigation.

Prevention is the best practice

Preventing contamination and protecting existing water is much easier and more practical than trying to clean up a contaminated source.

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